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ABSTRACT

This unit presents the teacher with guidelines and suggestions for a field trip to a shore. It contains information about what organisms and habitat to expect and appropriate activities. Also suggested are discussions of the people who live and work near the shore. A pre-trip planning section is presented. Sections relating to each of several disciplines are presented, including objectives, materials, and procedures relating to the field trip and designed to portray concepts of the discipline. Appendices of resources and sites in northern New England are provided along with a bibliography. (RE)

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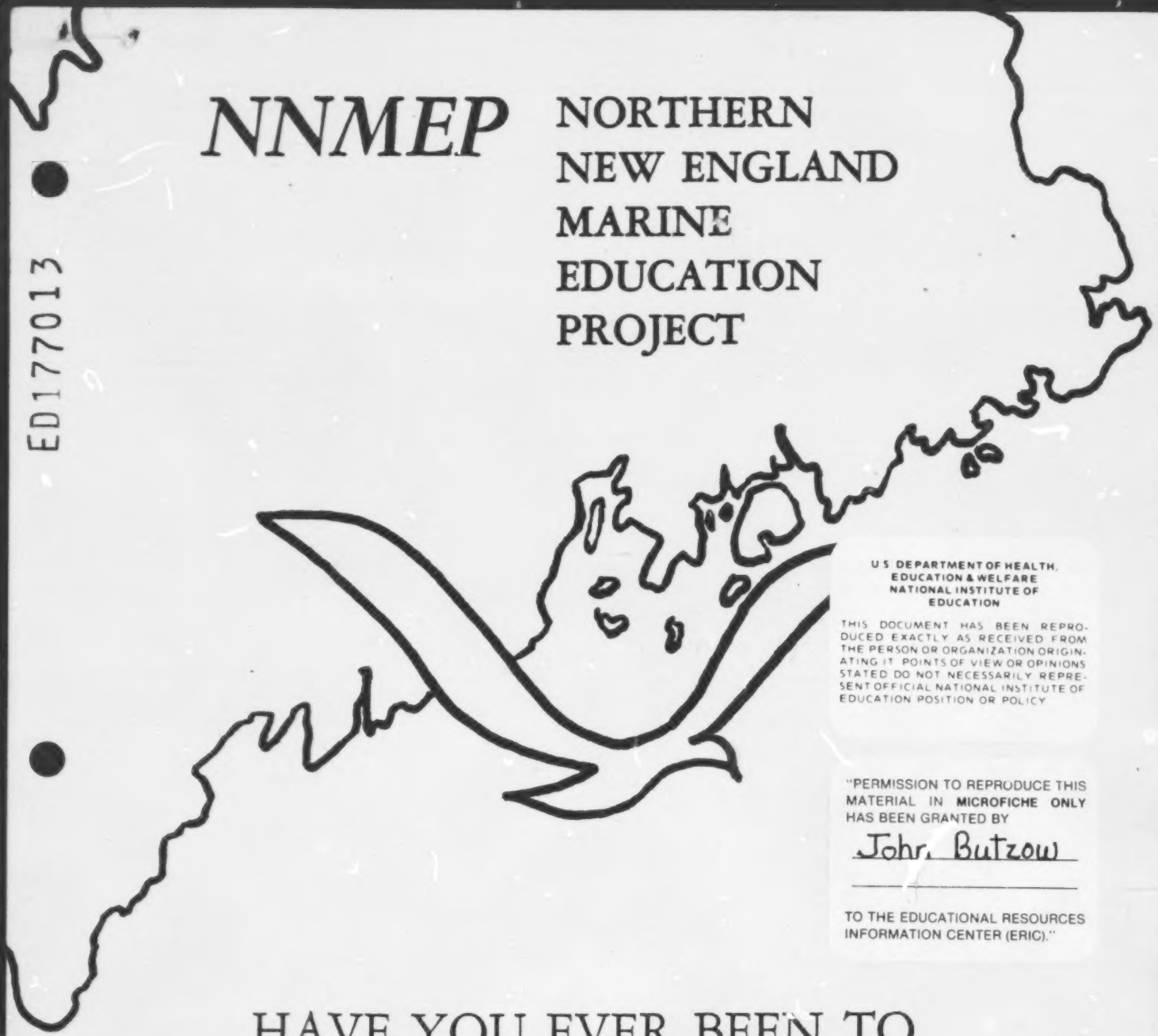

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HAVE YOU EVER BEEN TO THE SHORE BEFORE?

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Northern New England Marine Education Project

College of Education
University of Maine at Orono
Orono, Maine

HAVE YOU EVER BEEN TO THE SHORE BEFORE?

A Marine Education Infusion Unit

A Maine - New Hampshire Sea Grant Project
Supported in Part by NOAA, Office of Sea Grant
U. S. Department of Commerce and by
The College of Education, University of Maine

TITLE: HAVE YOU EVER BEEN TO THE SHORE BEFORE?

*MARINE CONCEPT: 3.21

3 Marine organisms interact in complex ecosystems.

3.2 Marine organisms are adapted to their environments in different ways.

3.21 Marine organisms are adapted developmentally, structurally, functionally, and behaviorally to their ways of life.

GRADE LEVEL: 4 (4-6)

SUBJECTS: Science, Language Arts, Art and Music, Math, Social Studies

CLASS PERIODS: Variable

AUTHORS: Wes Hedlund, Julia Steed Mauson

CONTRIBUTORS: Barbara Bean, Dick Bednar, Betsy Gagnon, Louise Merrill, Nancy Sylvester, Joanne Wholley, Sally Zelonis, Lorraine Stubbs

ACKNOWLEDGEMENTS: Paul Ring, Dave Dow, Bob Pratt, Dr. John Comitto, Dick Glueck, Lorraine Stubbs, Rena Smith

EDITED BY: Harry H. Dresser, Jr.

*From Marine Environment Proposed Conceptual Scheme
Robert W. Stegner, 310 Willard Hall
University of Delaware, Newark, Delaware 19711

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INTRODUCTION

This unit was designed to give the teacher some guidelines and suggestions to facilitate a trip to a shore -- primarily a rocky shore. It contains information about the organisms that you will discover there and activities that you may do associated with your field trip. While you are down to the shore you may want other experiences that are related to what the people who live and work there do. Suggestions are made in this area too. It is stressed that organisms are left where they live best -- in their own environment. Over collection is discouraged, but you may want to take a few representatives back with you. Most teachers are successful if they keep this simple. "Bring em' back alive in a jar" is one way to keep a few representatives, and setting up a small aquarium is another. Whether you are new to teaching or a veteran, this unit will help you make your visit a successful one and will be a stepping stone to further exploration to other shores and the wonderful world of water.

PRE-TRIP PLANNING

A. Choosing your site

1. Consult the back of this unit for possible field trip sites.

2. Check the available on-site resources. Are there local people, state park naturalists, rangers, cooperative extension agents who may help you?

3. Are there restrictions such as permission from land owners, state park officials, town or state ordinances on collections of shellfish?

4. Assess your needs. Is there available parking for buses? Find out about other facilities such as restaurants, restrooms, local marine museums, lobster pounds, aquaculture grow outs, oil terminals, commercial fishing wharfs, aquariums, guided programs, etc. Check the back of this unit for suggested areas.

5. If possible visit your site before conducting the trip. How long do you want to make the trip? Mentally rehearse the activities you wish to do. Perhaps you may want to take several trips.

6. Plan to arrive at your site at least one hour before low tide. Consult tide charts from your local papers or tables from marinas, chambers of commerce, gas dealers, etc.

B. Arranging Busing, Meals

1. Are buses available to you for day long trips?

2. Provide bus drivers and school administration with your planned time of departure, arrival, map of the area, list of students.

3. Check on insurance coverages. If buses are not available you may have help from private cars. Day long insurance polices are available.

4. Take enough food and water. Facilities may not be available for this. Students could plan their own menus. This could be a fun activity. It may be cold - warm drink and high energy food is important. Consult the activities area for suggestions. In any case, plan well balanced meals.

C. Get Extra Help

1. For success, organization, discipline and safety be certain you have enough adults to assist you. One adult per five students is suggested. Parents, cooperative extension agents and college students are good sources.

2. Read over your teacher background material, view the slides on intertidal life and inform yourself as much as time allows. Get your volunteers involved with the pre-trip planning. Get their "feet wet" and introduce them to the materials of the unit. The success of the trip depends upon you and them.

3. Assign volunteers to specific activities and explain these activities to them.

D. Advise Parents

1. Talk to them individually or at least prepare permission slips to be taken home.

2. Provide them with a checklist on student needs such as food, warm clothes, etc.

E. Prepare for Emergencies

1. Bring a first aid kit - check it and know how to use it. Plan evacuation in case of an emergency.

2. If your trip is in the fall, dress warmly in layers and have wool clothes. If these get wet you still have protection. If it rains, have alternate plans or make your trip shorter. You may center your investigations on how animals and plants are adapted to this condition. You do not need fair weather but the comfort of your students is important.

INSTRUCTIONAL OBJECTIVES

At the conclusion of this unit, each student should be able to:

1. Identify pictures, slides or dried specimens of animal and plant life found along a typical rocky, intertidal area;
2. Tell a story or keep a journal about a favorite marine animal;
3. Describe some interesting behaviors of marine animals;
4. Make a mural or discuss how and where some of the intertidal life lives;
5. Explain verbally how some organisms are protected from hostile environmental conditions:
6. Illustrate the role some animals play in a food web;
7. Measure temperature, make a small graph measure volume, keep a record of observations;
8. Describe how animals of the same type differ in size, weight, shape; and ,
9. Write about or draw pictures of places and things they have seen or the coastline or in a harbor.

HAVE YOU EVER BEEN TO THE SHORE BEFORE?

Teacher Background:

Maine has over 3,500 miles of shoreline if one were to follow her irregular coast. For some people it would be inconceivable to walk that distance let alone explore the life found during such a trip. Now imagine a low tide of 8 or 9 feet revealing an even greater area teeming with living organisms. Yes, it would take a lifetime to see everything the Coast of Maine has to offer. Many fertile areas are inaccessible except by boat. The outer islands of Maine, for example, offer some interesting opportunities for exploration.

Many people of the inland areas of Maine seldom have the opportunity or the time to become aware of the coastal environment. It is the intention of this unit to provide some guidelines and suggestions to help you and your pupils prepare for some coastal activities. The length of these excursions and the types of activities you do will, of course, be dictated by the distance you will have to travel and the types of sites that are closest to you. At the end of the unit you will find some resources and lists of possible field trip sites along the coast. Study these carefully and visit some of them. You may even find a better field site. Above all, plan your trips well in advance. The best time to do these activities is in the fall and spring. Life is most abundent then and there is greater safety in exploration. Whether you are a neopayte or a veteran in the outdoors, this unit will provide you with some ideas for activities before, during, and after your field trip to the shore.

Incidentally, there may be other activities that you may want to do while you are down to the shore besides looking at the various plant and animal forms. Perhaps there is a lobster co-op, a grow out or aquaculture area, a marine museum, a busy fishing pier, a fish cannery, an oil depot, a port, a boat building yard, or a marina to visit. Any of these could provide activities centered around history, socio-economics, literature or art. These experiences are unique and worthwhile. Why not try to plan one of these into your field trip? Consult the back of this unit for suggestions for resources and sites.

ABOUT THIS AREA WE CALL THE SEASHORE

Some of you are about to become like travelers visiting some strange new land. You probably are not scientists or biologists, but you may have something that they possess - curiosity. This will carry you far. Since you are not biologists and do not know everything about seashore life, let this unit be a guide for you. It is not the intention of this unit for you, the visitor to this unique realm, to learn every single organism and its scientific name. There are hundreds of different plants and animal species to be found in our intertidal zone. You will be concerned about the general picture of seashore life as well as the interrelationships among organisms there.

Learning to identify some simple plants and animals of the intertidal zone will require learning a few new vocabulary terms. The terms required will be kept to a minimum in this unit so that you can learn them quickly before taking your students to the shore. Slides and line drawings which accompany the unit will help you become familiar with the organisms you are most apt to encounter on your field trips. You may find egg cases, shells, skeletons and dried dead bodies washed up on the shore in seaweed. They are part of the flotsam and jetsam now, but they may have previously lived offshore below the tide. Some of these forms would be well beyond any low tide. The only way you may see them would be from visitations to a marine aquarium like the New England Aquarium in Boston, or Dave Mills' Oceanarium in Southwest Harbor. If you are lucky, a local diver or lobsterman might be willing to bring some of these oddities into your classroom.

There are many large plants and animals, but there are also many which are very small. Some of them would have to be looked at through a magnifying lens (10X) and some are so small that a microscope would be needed to see them. With the help of a local biology teacher you may be able to bring this microsome in a drop of sea water to your pupils.

Clearly, there are many directions you may go in your study and areas you may visit. Use this guide as a tool modify it in any way you see fit.

Types of Shores and Their Subdivisions

Basically, the shore is where the sea meets the land. The sea interacts with the land at different levels because of the tides. Ideally, you would like to visit the shore to see as much as you can. The best time is called a spring tide. This doesn't mean in the spring of the year, but it is when the tide is the highest and lowest at certain times of the month. This time is during a full moon or a new moon. Neap tides occur during the first and third quarters of the moon and represent the smallest changes in tide height. Not as much of the shoreline is exposed during low neap tides. You will have to consult your local newspaper for the tides or get a tide table from a marina or some other source. Some of the oil companies give out free tide tables through their dealerships. On the basis of the various levels of tides, the shore may be subdivided into the following:

1. The Uppershore

This region is only covered by extremely high spring tides. Since it is mostly uncovered and exposed during the month, this area is sparsely populated by marine flora and fauna.

The splash zone is the very upper area of the uppershore which only gets wet from the sea spray. Mostly land dwelling creatures inhabit this area as well as some air breathing periwinkles and a small amount of rockweed.

2. The Middle Shore

This is an area that gets covered and uncovered twice a day by our local average tides from 8 to 12 feet. The real shore plants and animals are found in this area and occur in great abundance.

3. The Lower Shore

This area is only uncovered under the extremes of spring tides. You would expect to find an abundance and variety of marine organisms here. There is less need for adaptation in this region and more animals are able to live in this zone.

4. Sublittoral Fringe

The above areas of upper, middle and lower shore are often called intertidal (between the tides) or, historically, the littoral zone. The sublittoral fringe represents an area that is never completely uncovered. The Kelps would be found here. This area has more variable conditions than the open sea. You may be able to dip down to reach a few organisms in this zone, but you would not in the next zone.

5. The Subtidal zone

This is a realm that extends beyond your reach completely unless you don a pair of fins and a mask . (see diagram).

Maine is well known for its rugged, rocky coastline; but it has actually four main types of shore. They are rocky, shingle, sandy and muddy shores.

The Rocky Shore

There are many different types of rock found making up our coastline. In the southern areas of our state we find a type of shist as in the Scarborough and Cape Elizabeth area. Further northward or "Down East" the granite becomes more dominant. The pink granites around the Acadia National Park area are very well known to people around the country. Schoodic Point has this type of granite as well as another type of igneous rock called basalt. They were formed between the granite as dark bands or intrusions called dikes. For anyone interested in this type of rock formation there is a nice tour of the Acadia Region and a

guide book of that area of the coast from the Golden Book series. Some rocky shores consist of flat, rocky platforms while others offer steep rugged cliffs which are quite dramatic. The most productive areas to visit are those rocky shores which are gently inclined, have securely based rocks with crevices and overhangs, and have a wide range of tidal pools from the upper to the lower shore. If the rocks are like cobble stones, i.e., very round and smooth, they do not offer good areas of attachment for marine plants and animals. Only the most hardy of plants can establish themselves on these rocks. They are the bluegreen algae which make it very slippery for students walking around at low tide. They are microscopic and are not easily seen. They form a dark carpet over the rocky surfaces. This can be seen at Grindstone Neck, Winter Harbor. The angular rocky beaches which are well established with rockweeds (see Rocky Shore) offer the best hiding places for animal forms. Yes, there are many life forms that may be found, the only problem is you have to look for them. This is a good observation test for both you and your pupils.

WHERE TO LOOK FOR MARINE PLANTS AND ANIMALS ON A ROCKY SHORE

One of the most important observations you and your pupils will make is that there are noticeable horizontal bands or zones formed by the various types of algae (seaweeds) and animals. They have adapted themselves to vary narrow areas. These bands are more distinctly seen on sharp vertical cliffs. As the slope of the shore decreases, these bands begin to run into each other. Try to observe these when you go to the rocky shore. Some biologists have actually divided the rocky shore into zones of life and given them names by the most dominant organisms in them. There are basically six of these zones. Before introducing these zones remember, too, that there are inhabitants above the upper shore. If the area is bare rock you may find orange or green lichens. These can be seen clearly with a hand lens. A good text to learn more about these plants is the Non-Flowering Plants, a Golden Nature Guide available in most paperback book stores. You could discover that it is not one plant but two microscopic plants. One is called a fungus, the other a green algae. They help one another. The algae provides food while the fungus can absorb water. You may discover different types of plants and shrubs that inhabit regions where there is a minimum of soil. Such plants as mosses, beach peas, wild strawberries, glasswort are a few representatives. The Spruce trees are the most dominant of the coastal trees. They are very hardy and grow close to our shores.

As we proceed down into the six various marine zones, the first zone is called the black zone. This is inhabited by primitive, microscopic blue-green algae. These were described earlier. The growth of these algae is so concentrated that the rocks appear black or very dark green. When these are exposed for a long time to the air they dry and the rocks appear to be different rocks than those above. If one were to scape a few of these algae with a pocket knife, the lighter rock would be revealed beneath. That small area uncovered would be quickly recolonized. These organisms and many other marine organisms grow in a succession not unlike many land forms that grow on bare rocks: lichens to moss, moss to shrubs, shrubs to trees, etc.

Take an old Coke bottle or a piece of wood, tie a piece of rope to the object. Secure the rope to a wharf piling and leave it for a few weeks. You will notice that life forms are quickly attracted to submerged objects.

The next zone below the black zone is the periwinkle zone. One of the three most common types of periwinkles live here. This is called the rough periwinkle (Littorina saxatilis). This animal has distinct whorls in its shell and is light grey. Its trap door is called an operculum and when it is shut very tightly, the periwinkle can live for weeks out of water. This periwinkle does not just stay in its zone but often wanders about into the black zone and the lower zone called the barnacle zone.

From a distance, the barnacle zone is visible as a white horizontal band. The barnacles crowd so close together in some areas that they form a very uniform band. This density and the sharpness of their limy shells provide a few scratches for anyone falling on them. Any diver will tell you stories about these creatures. For one thing the only time you can clearly see part of the animal is when the water covers them at high tide. They open part of the upper plates of their conical shell and shove out their six pairs of lacy legs to capture food and oxygen. If you are real quiet, you may come upon these in a shallow pool of water and hear them close their doors quickly -- swishhhh! At one time during March and April these animals were swimming in the sea and looked quite different then they look attached to the rocks. The larval forms (see Rocky Shore diagram) or juvenites search out a suitable area for growing and change their body form (metamorphosis) to become adult barnacles. These animals are really arthropods and custaceans just like lobsters and crabs, although this is kept quite secret as they stay in their shells. They are very well adapted to where they live. Their conical shells and strong cement enable barnacles to withstand tons of pressure from the waves. They also close their doors so securely that they can stay alive for long periods of time exposed to the dead cold of the winter or the baking hot sun of the summer.

All through this zone and lower zones, you may find the dog whelk (Figure 9, 50). This highly carnivorous and at times cannabalistic organism is about the size of the common periwinkle. It is usually found among the barnacles and also around blue mussels when they are present. It is able to move about on a mucus trail with its slimy foot and is quite capable of prying open the valves of barnacles and of young mussels and penetrating the soft tissues with its proboscus (tubular structure). These animals also feed on larger bivalve (two shelled) molluscs such as the adult blue mussels, by boring perfectly round holes through their shells with a special file like mouth part called a radula. The whelks also release a chemical enzyme to soften the shell. These whelks can be easily identified and distinguished from the periwinkles by their pointed spire. Turning over the shell will expose the trap door (operculum) which is oblong. The operculum of the periwinkle is round. The color of these organisms varies from white to beautiful bands of brown and tan. It seems that this pattern is determined by what the whelk eats.

In late spring and through summer these molluscs lay their conical eggs in clusters in crevices or on the bases of seaweed (see figure 9). The anal gland of this organism secretes a rich purple stain which was used to dye royal robes in early classical times.

Occurring not so commonly in the barnacle zone is another mollusc of one shell called the limpet (Figure 25, 42). This is also known as the tortoise-shell limpet or chinaman's hat. This gastropod (one shelled, one footed mollusk) is planktonic when young and like the barnacle assumes a conical shape when it becomes a settled adult. Its resemblance to the barnacle stops at this point. The low contour of the limpet's shell and flattened broad shape makes this animal very well adapted to a wave washed zone. The limpet has a very large fleshy foot under the shell which is easily observed when this animal is attached to the wall of an aquarium. The limpet attaches itself to the rocks with its foot and moves about during grazing with this foot. The limpet feeds primarily on algae.

Another periwinkle in the barnacle zone is the common periwinkle. It grows quite abundantly and in some cases will form a narrow zone itself called a periwinkle zone. It is very dark gray to brown and may exhibit bands when wet. The area of its trap door (operculum) looks like a slightly compressed 0. Its adaptation and movement is like that of the other periwinkles. With the aid of a thin amount of mucus around its operculum the animal glues itself to the rocks or seaweed at low tide. When the foot is pulled in, the trap door closed, the animal is protected from drying out. Like other gastropods it has a radula for grazing on algae.

In some areas we also find small juvenile blue mussels (fig. 11) or their adults in small dark crevices. If the area is optimum for growth, these mussels will grow in a distinct horizontal band. It is related to other bivalves (having two shells) like the clam, although its foot is very much reduced. The common name of this animal comes from the fact that it is generally a deep violet to dark blue. When it's alive it's covered by a protein horny layer - a rather blue-black skin which often wears off when the animal dies. One of its peculiarities is its byssal threads which resemble a thread-like beard. It uses these to attach itself to rocks, pilings, or small stones. These protein fibers may be made or absorbed at will and allow for some movement to different areas. If you pull the mussels from their attachment you may also find small crustaceans and worms attached to these threads. The crustaceans are amphipods like Hyale nilssoni (see diagram) whose bodies are compressed on the sides, are orange in color, and have small black eyes. They usually hop about when touched. Small round worms called nematodes, segmented worms called oligochaetes, and ribbon worms also find shelter in the byssal threads of the blue mussel. Other forms of life may also wash up into the barnacle zone or some of the above may be completely absent depending on the area, exposure to wave action and slope of the beach.

The next zone is the very conspicuous rockweed zone which is dominated by two types of brown algae. These plants grow so profusely that this also is called the brown zone. The first brown algae is bladder wrack or rockweed (figure #1). These plants are olive-green to dark brown, regularly branched, with a tough leathery body. The branches may be somewhat spiraling and usually have paired air bladders with a central structure (mid-rib) running down the length of the body (called a thallus). At the tips of these plants reproductive structures may also be found from late spring through summer. It has a stem-like structure named the stipe and a root like structure used not for nourishment but attachment. This is called a holdfast. Seaweeds or marine algae have no true roots, stems, or leaves. They do not need these structures because the watery environment provides support (bouyancy) and nourishment. These plants have some commercial uses, too. Bladder wrack has a high vitamin content in the fall and can be used for tea, as mulch for gardens, as packing and insulating material for collecting speciments, and shipping lobsters or baitworms and, of course, for traditional Maine clambakes. Intermingled with the bladder wrack (Fucus) and occuring lower down in the rockweek zone is the knotted wrack (Fig. 2). This perennial is more stringy. The alga is very tough and olive-green to yellow-brown. It too has small air sacs along the length of its branches which aid in its flotation. There is no mid rib and the hold-fast is very small (see Fig. 2). These algae usually have all kinds of other plants and animals growing on them.

The hydroid, Hydractinia echinata, grows all over the discarded periwinkle or moon-snail shells inhabited by hermit crabs (see Fig. 15). Other hydroids resemble plants more than animals. Some grow in branches and the ends of their polyps equipped with flower-like tentacles appear almost rose-like with their pinks and reds. These animals may be found on algae in the intertidal zone, on pilings, or lobster traps.

The Rockweed zone with all its seaweed provides protection for other plants and animals, especially when the tide is out. The bladder wrack and knotted wrack retain moisture as they drape dense over the rocks. Looking carefully in this area, one may turn up such things as green crabs (Fig. 13, 76) which can be a real source of enjoyment for your pupils, limpets (already discussed), the common periwinkle, the smooth periwinkle (Fig. 47) (smaller than the other periwinkles), little crustaceans such as amphipods (Figs. 70-74) which when disturbed hop around (these are not insects), blue mussels, barnacles, dog whelks, scaleworms (Figs. 19, 59), and occassionally sandworms.

Another animal often discovered in this zone is the tube worm, Spirobis, (Figs. 23, 63, 64). This animal superficially resembles a barnacle but on close examination has a coiled shell made of calcium (white). When the animal is underwater it relaxes and its tentacles may be observed, when disturbed or at low tide it closes off its tube with an air-tight door structure called the operculum. It plugs the tube in much the same manner as a periwinkle does. These animals may occur on rockweed, giving it a white spotted appearance or it may be found on rocks, the shells of snails, crabs, etc. Some of the coils form in a left handed pattern; others develop in a right handed swirl. In fact, the animals are separated by species by their shape and the preference for habitat. These little animals have an interesting reproductive and larval development. They brood their young in and egg sac inside their shell. After a month or so in June or July the young hatch out, perhaps under a full moon. They then swim to the surface waters and search for adult populations, for they are gregarious. These ciliated pink larval forms are only a fraction of an inch long. When they find a suitable habitat they will spin a calcium tube to live in within 24 hours. There may be other organisms found in the rockweed zone but this description should give you an idea of how rich in life the area is.

The next zone down in the lower intertidal zone is called the Chondrus zone or red algae zone. These algae are usually only found on exposed sea shores and when present offer a tremendous living area. So when picking a site where you want to see an abundance of life, use the presence of this algae as an indicator. Sea or Irish moss (Fig. 3) is probably quite familiar to most of us, especially those foragers who have tried some of our edible seaweed along the Maine coast. Have you tried Blanc Mange (moss pudding) lately? The red algae is a perennial seaweed which grows in dense colonies on rocks from low tide into 20 or more feet of water. The colors may vary with these plants from bleached-out white to a yellow-green or even a pinkish-green. The reason it is placed in a group called the red algae is because the primary pigment in its body is red. This may be masked by other pigments to give it slightly different hues, however. The plant is bushy,

double-branched, and composed of many blades which become very slender as the holdfast is approached. It may grow from a few inches to six inches. If it is picked, the blades will lie fairly flat in one place. This plant has been used commercially in Maine and other states, as well as Europe. We have Marine Colloids Company in Rockland that uses some of Maine's algae and imports others from all over the world. Irish moss is a source of a phyco colloid called carrageenan which is used as a stabilizer in chocolate milk, mayonaise, toothpaste, etc. Check the package ingredients the next time you pick up some instant pudding; you will find it listed as calcium carrageenan.

Irish moss is a great surface for attachment of such things as oval windows (Bryozoan), Spirobis (tube worms) and other forms of animals. Scale worms, round worms and little amphipods may be found around its holdfast as well as small blue or bearded mussels and periwinkles. If you pick up a small stone with this Irish moss growing as a clump, you may find a whole small community. Coralline algae is a red algae which encrusts rocks and gives them a reddish color. Several distinct types may be found on the Maine coast.

There are many species of red algae that grow in this zone. Porphyra (Fig. 6a) is a very thin membranous seaweed. It resembles sea lettuce (Ulva) (Fig. 4) which grows in tidal pools higher up in the intertidal zone. Porphyra looks like purple tissue paper and is often found growing on coarser algae like Fucus. This plant is particularly important as food in the Far East and even Hawaii. This economically important species is used as food and as a source of salt.

Another red algae called dulse is fairly well known as food in the U.S. Perhaps you have seen this in a cellophane package in your local grocery. Although this is commercially harvested in Nova Scotia and New Brunswick and sold to the U.S., we commonly have this occurring right in our own intertidal zone! It is chewed in small amounts with soup and sandwiches or eaten like "potato chips" when dried, or chewed raw like gum. Dulse grows with blades extending up to 20 inches with an average about 8 inches. When wet dulse feels slippery and has a very tough leathery texture. You may find this on other plants, rocks or even on mussels. If you haven't tried it - do so! Dulse is a source of protein, carbohydrates and fats, is high in iodine and phosphorus, contains vitamins B_6, B_{12}, E and C and is rich in trace elements. Dulse salad anyone? There are many other forms of red algae occurring in this zone; some are very lacy and pretty. You would need an additional key to study these. Several source books are listed in the back for reference.

Further down in the red algae zone you may find other forms of plant and animal life in crevices, overhangs or isolated pools. One organisms usually uncovered is the crumb-of-bread sponge (Fig. 18, 33). This simple animal filters the sea water through its porous body to obtain plankton.

Once or twice a month you may find such animal forms as the green sea urchin (Fig. 29, 83). It is easily distinguished by its egg or globular shape and of course its blunt spines. The urchins mouth is located on its bottom side and you may observe its method of chewing if you turn it over. Its beak-like jaws are used for scraping algae off rocks as it moves along on its tube feet just like its relative the starfish. If you look high up into the intertidal zone you may find pieces of the shell discarded by sea gulls after their "bombing runs." You may find its whole skeleton called a test or part of its mouth supportive structure called Aristotle's lantern.

In any case you may discover how symmetrically and elaborately this organism is constructed. Live urchins may be found in crevices, in pools, or under seaweed. Could you think of any more reasons why this animal is placed in the group of "spiny-skinned" animals (echinoderms)?

Perhaps if you find the starfish in the same zone you will discover that these animals have tough skin as well as spines and tube feet. There are two or three possible starfish you may find in this red algae zone and lower. They are the Northern or purple, lavender sea star (Fig. 79) and the common starfish (Fig. 80). The common starfish is usually green or blackish-green. The Northern starfish has five arms, but its body is not as firm and there are no definite lines on the top of its arms. Some of the interesting things you may observe are their regeneration of lost rays, or their strange way of feeding. The sea star usually feeds in a humped-up fashion with its legs wrapped around a soft shell clam, mussel or periwinkle. It attaches firmly to the two shells with its tube feet by means of suction and pulls the shells apart by exerting a continual pressure. With the help of muscle relaxants that the starfish releases into the water, the mollusk tires and the shell is partially opened. The starfish then turns its stomach through its mouth and onto the soft body parts of his victim and literally digests him externally. What is left after this feeding is an empty shell partly opened - no longer containing its former inhabitant. Other less commonly found starfish are the brittle star or daisy star (Fig. 82) and the blood star (Fig. 81). The brittle star is, as its name implies, quite fragile. It is easily recognized by its serpentine rays. Usually this is all one may see for they often are hiding under loose rocks. Their bodies are very thin and their center is disc-like. The blood star resembles the common starfish but when one turns it over the tube feet are not very conspicuous and only occur in rows of two while the common starfish has rows of four.

Near or below the low tide mark, one may also find several types of sea anemones. One is the flowering anemone (Fig. 35). If it is relaxed and covered by water, its tentacles extend enabling it to capture minute life forms such as plankton. These tentacles have special stinging cells armed with a toxin which paralyzes the prey. This animal has a body form called a polyp which does resemble a flower for its tentacles appear petal-like and its cylindrical body, stem-like. If this animal is disturbed, it withdraws the tentacles into its body. This animal is harmless to man.

Another mollusc of this zone is the chiton. Like the limpet it has one shell and a very muscular foot and feeds on microscopic vegetation but unmistakably different are its eight overlapping plates which composes its shell.

The last Rocky Shore zone is the laminarian zone. This zone never completely becomes uncovered by the receding tide. While you will only see this zone partially exposed on extremely low running tides, there are several algae that you may observe from the surface. These are the very large kelps. One resembles the fingers of one's hand (Fig. 76) and another appears like a very long ribbon. You may see these forms washed up with other algae after a big storm. Their whip-like stripes are unmistakable. There are many other life forms in this zone, some of them may be identified with the use of the suggested guides in the back of this unit.

The above zones are by no means complete in their descriptions but point you in the right direction. Within the rocky shores there are certain distinct environmental areas that you should consider. Some of those environmental areas are discussed in the ensuing sentences. Bare rock surfaces provide places for the attachment of highly adapted animals, such as barnacles. Weed covered rocks offer endless shelter for a large and diverse animal and plant population. Rocky tidal pools which never dry out provide diverse habitats for many different species. The species which inhabit these pools vary from the lower to the upper beach. Overhanging rocks which retain some moisture beneath them harbor rich flora and fauna populations.

Perhaps you may not have a beach readily available to you for your trips. Sheltered areas in unpolluted harbors are very rewarding. A visit to a local wharf leads one to the discovery that pier piles provide an extensive settling surface. There is a zonation and clustering of animals all over the surface. High up on the pier you may find barnacles, blue mussels lower down with all sorts of algae (sea lettuce, other forms) attached as well as sponges, hydroids, sea anemones, sea squirts (Fig. 84) and many other life forms. Not only do organisms live on the surface but also within wooden piles. Molluscan ship worms like the Teredo are a few worms that may live within pilings. Examining floating timers and driftwood will reveal this, too. Perhaps you may have students interested in not only the biology of these animals but also their economic implications like destruction of piers. Ask a local lobster pound owner what he thinks of these worms. If the water is clear you may also see small fish which are attracted to these biological surfaces.

SANDY SHORES -

Most of your study will probably center around the rocky tidal pool areas but beaches may be adjacent to the rocky areas. Students will not immediately see as many life forms and may quickly loose interest unless given observations to make and tasks to perform. Only by digging will the wealth of animal life be discovered. There is a zonation of life here as well as in the rocky shore. Most forms of life are excellent burrowers like the common soft shell clam (Fig. 21) and the sand worm (Fig. 61). Further out in shallow water areas you may discover hermit crabs (Fig. 15) (a real source of enjoyment to your students), and the sand shrimp which may be on the surface around eel grass. Only specialized nets may reveal these organisms. You may or may not want to undertake special projects centered around these areas. Suggestions are given in the back of this unit if you choose to pursue them.

Strand lines are areas where the jetsam and dislodged seaweeds are deposited on the beach. You will notice definite levels which indicate the level of highest spring tides and the most recent high tide. Examining this mass of debris will reveal sand hoppers, land insects, and many other forms of animals.

MUDDY SHORES -

There are many areas sheltered, muddy areas that you may observe. Investigations in these areas can be a real problem with younger children in terms of safety and keeping a group together. A visit to this area should only be done with small groups. It takes time to get around on a mud flat! Perhaps you may get assistance from local wormers, biologists or cooperative extension agents who would be willing to bring things in from this area. Certainly a trip to the shore of the mud flats would be quite revealing, too. Shore crabs such as the green crab, small rock crabs, periwinkles, mud snails, shrimp, amphipods, razor clams, soft shell clams are just a few of the animal forms you may see. The various types of eel grasses (with their important root systems), succulent plants such as salt wort, sweet grasses, staghorn, beach pea, strawberry, raspberry are a few of the shore plants you may discover. In the fall and early spring you may also notice the whole mud flat covered with green algae and eel grass. Numerous fish have their growth in these areas. Some which are successfully captured are the stickleback (Fig. 8) and the mummichog which are excellent and hardy fish to keep in the classroom.

SHINGLE BEACH -

These beaches are made up of pebbles and rounded stones. They are generally steep and exposed to a lot of wave action. These are the most unstable type of shore you may visit. The rolling stones do not allow much life to gather on the surface. These beaches are interesting from a geological standpoint, though. Storm beaches around the Schoodic Point area in Acadia National Park are good examples. Others are Little Hunters Beach and Grindstone Neck in Winter Harbor. The workings of the waves can be quite impressive!

The purpose of above discussion on types of shores and their respective forms of life is not intended to be learned in detail by either teachers or students. It is only a resource to help you plan meaningful seashore field trips. You may want to supplement it with other resources. The following texts are easy reading and well illustrated: the paperback Seashores (Golden Nature Guide; Questions and Answers About Seashore Life by Ilka K. List; The Handbook for Beach Strollers by Donald J. Zinn; and The Sea is All About Us by Robbins and Yentsch. In addition to this slides of the intertidal zone are available from the University of Maine at Orono, Audio-Visual Center.

LANGUAGE ARTS

Grades 3 - 6

Seafood Soup -- Creative Writing

Objective: To allow the child to be creative using the items collected during the field trip to the beach.

Materials: Several of the items collected during the field trip to the beach. Large recipe cards. Paper and pencil.

Procedure: Using only the items found on the beach during their field trip, the children are to invent a new recipe. They must:

1. List the ingredients
2. Give directions on how to prepare the dish
3. Name their recipes
4. Write what happened when they served it at home. Have them be as creative and "kooky" as possible. Read the recipes aloud to the class.

Title examples: Starfish Salad -- served on a bed of sea lettuce
Barnacle Buns and Jellyfish Jam
Seagull Souffle

POETRY - RHYMING WORDS

Objective: To help the child recognize and identify similar sounds -- verbally and visually.

Materials: Pencil and Paper - Poetry books.

Procedure: Discuss with your students what a rhyming word is, then read the following poem aloud:

WISH
By Dorothy Brown Thompson

If I could wish,
I'd be a fish
For just a day or two

To flip and flash
And dart and splash
And nothing else to do,

And never anyone to say
Are you quite sure you washed today
I'd like it, wouldn't you?

DICTIONARY WORK - GUIDE WORDS

(Good for morning after the trip)

Objectives: To give the children further practice using the dictionary.

Materials: Dictionary for each child - Paper and Pencil.

Procedure: Give the children a list of 15 words such as those below:

Barnacles, rock crab, jellyfish, mussel, periwinkle, sand dollar, scallop, skate, starfish, eel, clam, gull, tide, dune, and salt.

Ask the students to look up each work in the dictionary and list the guide words from the page. (See if they can make some crossword puzzles with them). This activity can be shortened or lengthened at the teacher's discretion.

Spelling: Sponsor a spelling contest using words from the sea, or have them make up crossword puzzles.

HOW TO ESTABLISH AND BUILD A MARINE AQUARIUM

Introduction:

If you mus: collect . . . then an aquarium (either temporary or permanent) in your classroom is a necessity. Saltwater aquariums are tricky, but certainly not impossible! Several good publications are already in print that give you lots of good information about aquarium setups (see bibliography). Our purpose here is to give you a bit of information to get you started.

Equipment:

Tank - sand - filter - aerator - seawater - pump - hydrometer - other equipment optional.

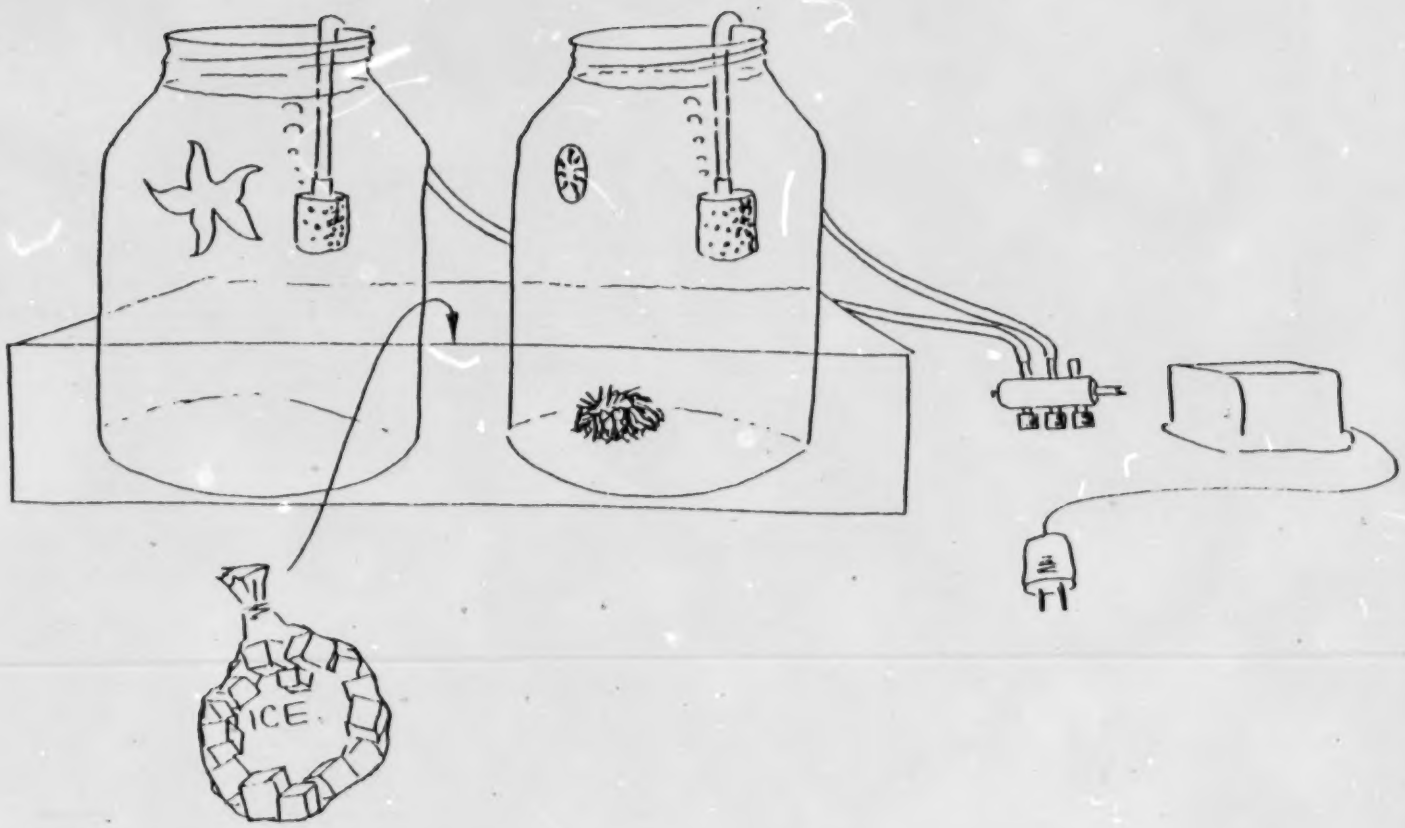
Methods:

Prepare your tank before you collect your specimens. Remember to allow about 24 hours for the tank to filter out the suspended sand and detritus that will be suspended in the water due to the setup activities.

First, buy, borrow or make a 10-15 gallon tank. This should be either glass or plastic as seawater will rust the stainless steel part of a metal-braced tank or corrode the aquarium cement. Also make sure that all of the equipment in your tank is plastic, since many metals are toxic to marine invertebrates. A subsand filter tends to be the most efficient, but the ordinary box-type filter is also effective. Sufficient aeration is very important and is crucial to the use of your subsand filter.

To begin setting up your tank, first wash it well. Then place your subsand filter and air pipes in the bottom. Above this layer pebbles and then sand. Next, fill the tank with seawater. (See Fig. 1). Allow the filter system to clear the water before adding your specimens. Natural seawater is advisable, rather than trying to mix artificial seawater.

When your system is set, you are ready to begin collecting your specimens. Remember to always make sure that you have permission to collect at your site. Decide what specimens you would like to have in your aquarium before you collect. When you collect, take only what you need and make sure you have provided for their comfort en route. Use plastic containers to carry your animals. Do not try to transport glass or metal containers while you are on the rocky shore. Small specimens should be collected and placed in plastic jars containing seawater. Overcrowding can result in the loss of all of your collection. A few live, healthy specimens are better than many dead or dying ones. One or two organisms per gallon of water is about right. In transporting the collections to their new home site, they must be kept cool. If you are traveling for any distance, place your containers in a styrofoam cooler with ice in between and fresh seaweed on top. Once at home, allow the speciments time to become accustomed to their new surroundings by floating them and their containers in your aquarium overnight to allow water temperatures to equalize. The water in your aquarium may not look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substantially different from the water your animals have been transported in, but to your new charges direct transfer to their new aquarium water could be a shocking experience.

The aquarium may be kept cold by enclosing it in a window area in the late fall through early spring months. Ice cubes placed in plastic bags and floated in the aquarium can cool the aquarium inexpensively for short periods. Aqua-chillers are complete units that can cool a series of aquariums or very large ones. These are quite expensive but maybe your students may want to raise funds through a project. The key to success in keeping organisms alive is to keep the water cold (about 40-50°F).

To maintain your aquarium, you'll have to keep the salinity of the tank stable. When you first fill the aquarium, mark the water level with a piece of tape on the outside of the tank. The density of the water in the composed aquarium is important and can be checked with a hydrometer (available at a pet store). It should show a reading of 1.025 when natural seawater is filling the aquarium. As water evaporates and the salt concentration in the tank rises, pure distilled water should be added to the original water level mark. Any salt accumulating on the edge of the glass should be scraped off the sides and returned to the tank.

To maintain your animals, feed them as follows:

The starfish and clams can be fed with frozen clams. Turtle food and fish food may be added to the water to provide nourishment for mussels and small fish. For a while you may try an experiment of adding a few extra mussels and not feeding the animals frozen food. In this more natural situation, crabs and starfish will find their own dinners. You and your students will have the opportunity to watch crabs and starfish opening the mussels. The small fish will "clean up" after the crabs are finished.

There are a few simple steps to remember for a successful aquarium:

1. Use natural seawater and maintain a constant water level.

2. Keep the water temperature low. If you need to reduce the temperature in your tank, float ice cubes in plastic bags or containers. Never add ice cubes directly to the water. Also, avoid rapid temperature changes.

3. Keep the water well aerated.

4. Don't overcrowd your aquarium.

5. Find out which animals are voracious predators. You may want to isolate these.

6. Feed your animals regularly and remove all uneaten food or dead animals to prevent fouling.

7. To avoid excess evaporation, keep the aquarium covered.

8. Keep the aquarium out of direct sunlight.

Specimens can be obtained from a marine supply house, but it is less expensive and more interesting to make your own collections. You can expect to find mollusks, crabs of various species, starfish, small marine fish, snails, barnacles, anemones and urchins, to name a few. Around a jetty or a rocky beach at low tide is the best place to look and collect. Collect various types of seaweed to enhance the attractiveness of the aquarium. You probably won't need any supplemental lighting unless you want to support several species of the green algae. The predominant red and brown seaweeds do fine with regular fluorescent or incandescent light from your ordinary lighting.

Additional resource materials and activities can be found in: The Aquarium, a second grade Maine education unit in this series.

Science Activities to be Used with Sea Aquarium -

1. What are the requirements of the plants selected? Determine predator-prey relationships of the animals selected for the aquarium. How do these organisms fit into the food web?

   a. Make a chart illustrating the role the animals and plants in your aquarium play in the food web.

2. Stop feeding the aquarium animals frozen food and stock the aquarium with a large supply of mussels. Observe results.

3. Speculate upon or do library research on the effect a variation of the salt content of the aquarium water would have on the aquarium's tenants.

Language Activities -

Have each child keep a journal of daily observations of the plant or animal of his choice. The journal may be picture or script, depending on age level.

Math Activities -

1. Record, chart or graph the life span of the different animals in the aquarium.

2. Record, chart or graph the growth of any animals or plants which can be measured.

3. Measure the water temperature. Graph the temperature.

4. Record periods of greater or lesser animal activity. Graph in relation to times of day, period of days or months of year.

5. Using gallon jugs, determine the capacity of your aquarium.

Art Activity -

Illustrate the appearance of the aquarium at different times of the day, specifically the effects of sunlight and shadows.

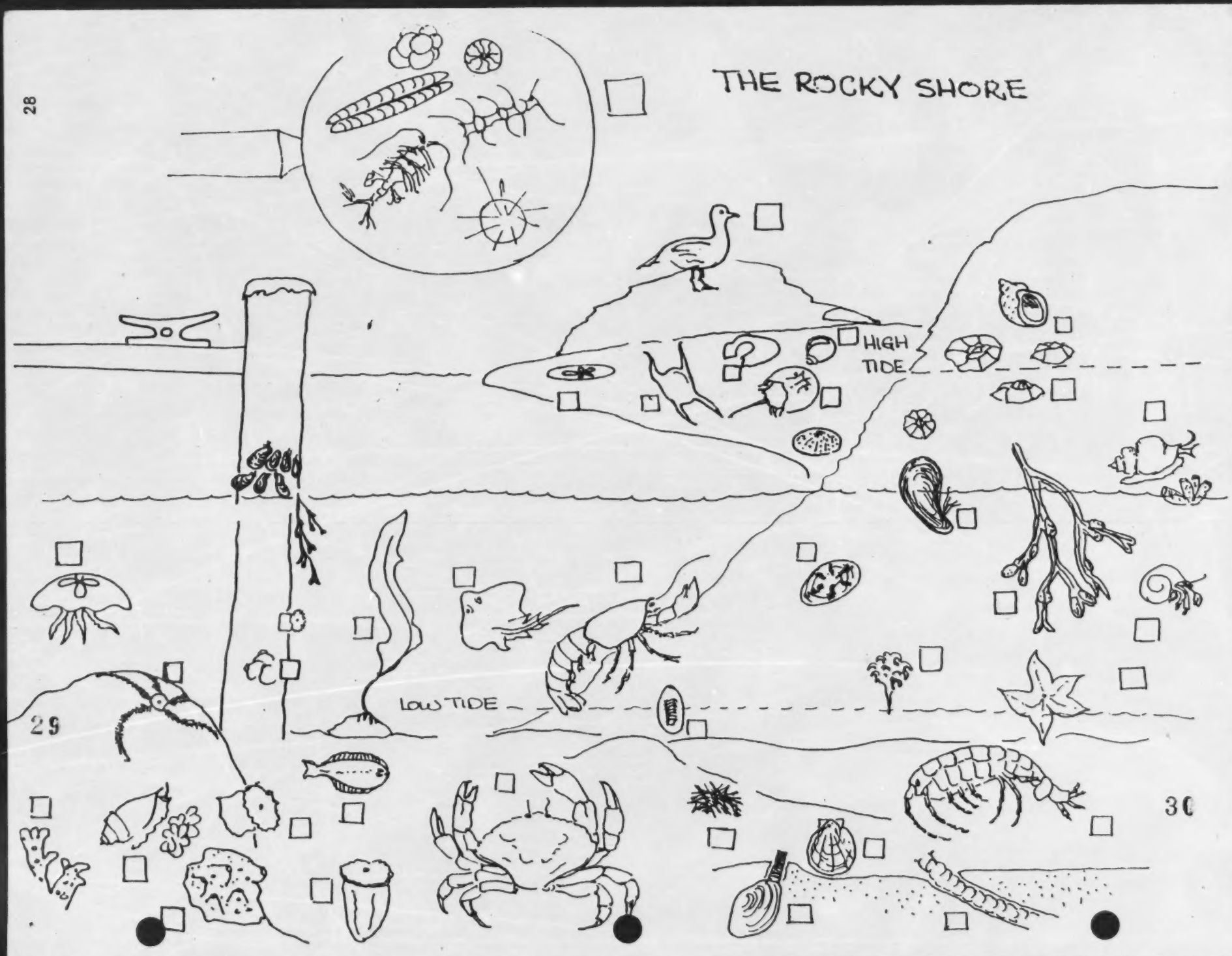
Other Activities -

For a more comprehensive unit on aquarium and associated activities, see The Aquarium by Steve Kilfoyle. This is one of the Northern New England Marine Education Project units. It was designed for second grade use, but is adaptable K-4.

Life at the Shore -

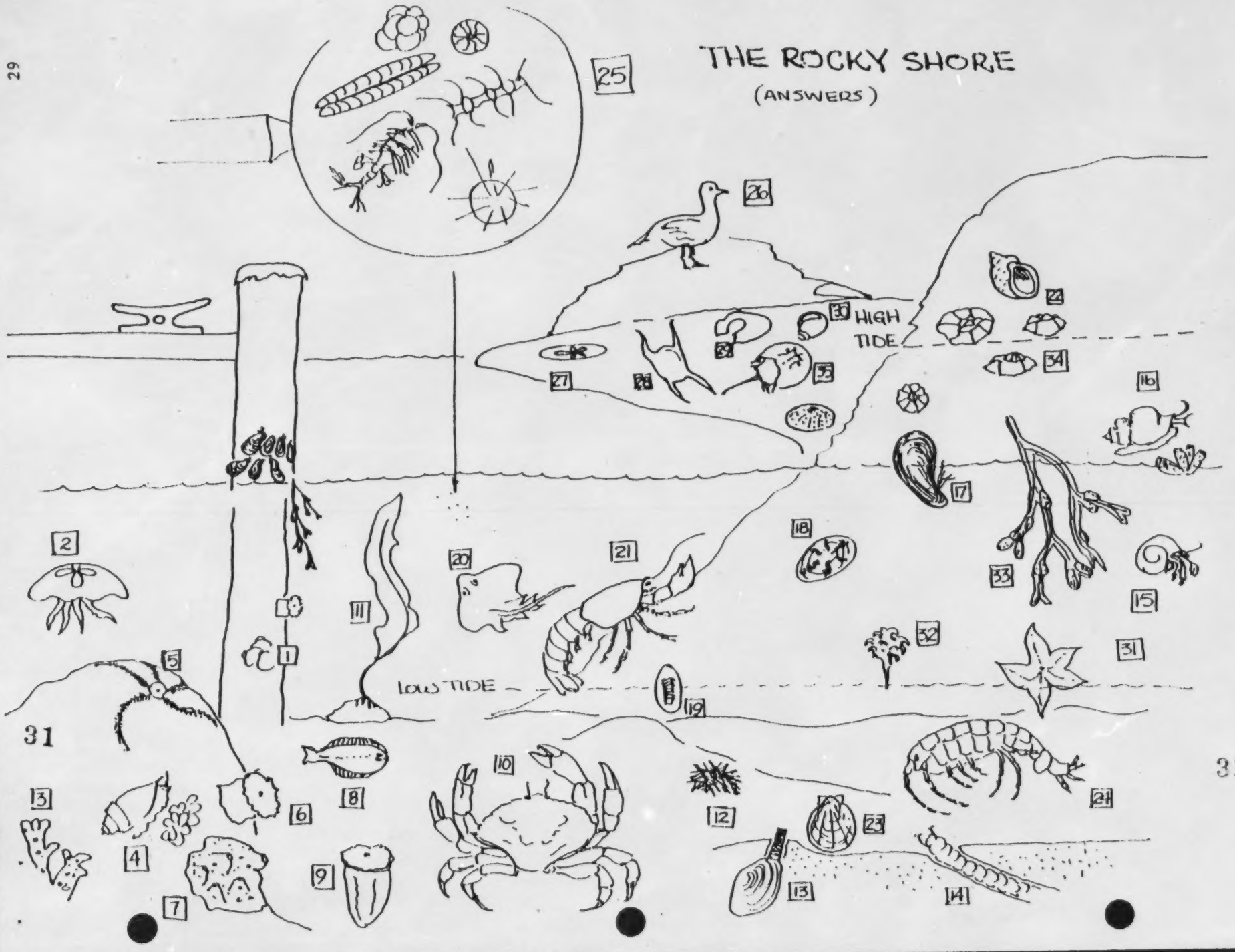
Look at the following picture. Match the names below with the animals and plants in the picture. Place the number of each item in the proper square.

1. Sea Squirt
2. Jelly Fish
3. Deadman's Finger Sponge
4. Channel Whelk & Egg Case
5. Brittle or Daisy Star
6. Sea Anemone
7. Crumb of Bread Sponge
8. Flounder
9. Sea Cucumber
10. Rock Crab
11. Kelp
12. Sea Urchin
13. Soft Shell Clam
14. Sand Worm
15. Hermit Crab
16. Dog Whelk
17. Blue Mussel
18. Limpet
19. Chiton
20. Skate
21. Lobster
22. Periwinkle
23. Deep Sea Scallop
24. Amphipod
25. Plankton
26. Herring Gull
27. Sand Dollar
28. Skate Egg Case
29. Moon Snail Collar
30. Moon Snail Shell
31. Starfish
32. Irish Moss
33. Bladder Wrack (Rockweed)
34. Barnacle
35. Horseshoe Crab


28
THE ROCKY SHORE
HIGH TIDE
LOW TIDE
29
30

THE ROCKY SHORE

(ANSWERS)



SUGGESTED MUSEUMS AND MEMORIALS TO VISIT

1. Grand Banks - Schooner Museum See marine and fishing exhibits of the "Sherman Zwicker" - a 142 Dory Schooner. Students may see the old "oil skins," method of storing and salting fish, equipment used. Take an entire tour above and below the decks. Open to Public, 9:00 - 9:00, 100 Commercial Street, Boothbay Harbor, Maine $.50/child.

2. Bath Marine Museum (7 days/wk from 10 a.m. to 5 p.m. from May 21 to October 23) There are four exhibit sites in Bath: Percy J. Small Shipyard, Sewall House, The Apprenticeshop and Winter Street Center. There are boat rides on the Kennebec River (seasonal). This trip will give some insights into what a shipyard in the days of old wooden sailing ships looked like, how the ship builders worked, lived along the shores from 1607 to the present. Tours of portions of the museum can be arranged for school groups during the school year. There is a charge for these tours.

3. Penobscot Marine Museum (Searsport, Maine) Searsport, at one time a century ago, produced one-tenth of all deep water shipmasters in the American Merchant Marine. The town was recognized for its ship-building and was the hailing port of many foreign trade vessels. See instruments of navigation, the articles brought back from Oriental trade, ship-building models, tools employed in shipbuilding and sea captains homes. Children: $.25 May 30 - September 30, 9:00 a.m. to 5:00 p.m. daily; 1:00 to 5:00 p.m. Sundays.

4. Maine State Museum See artifacts from the Revolutionary War vessel "The Defense." These have been almost perfectly preserved in the mud of the Penobscot River. Could generate a talk about how seawater, mud and marine life effects organisms in it. American first Navy was completely sunk in the river - hear some other stories about John Paul Revere.

5. Restoration Point (Bristol) - Colonial Pemaquid Restoration. Location of extensive archeological dig of 14 foundations from homes of 16th, 17th century settlements. See artifacts of earlier Indian inhabitation, too. Museum, restaurant next to the site (Rte 129 to Rte 130 from Damariscotta).

6. Fort Edgecomb (1808), Blockhouse, restored fortification built to protect Wiscasset area. Seals may be seen in Sheepscot River. Fort Edgecomb is reached by going South of U.S. Rte 1 at Edgecomb end of Wiscasset bridge.

7. Fort George (1779) - Fortification at earthworks under the flags of four nations - French, Dutch, English and American. Research and restoration underway. (Rte 166 to Castine)

8. Fort McClary (1846) - Hexagonal block house on site of a fort built in 1809. Fortified as early as 1715 by Massachusetts Bay Colony to protect their merchants from taxes by the colony of New Hampshire.

9. Fort O'Brien or Fort Machias (1775) - Overlooking Machias Bay at site of first Naval engagement of Revolution. (Breastwork remains, five miles from Machias on Rte 92).

10. Fort Popham (1861) - Fortifications here guarded the Kennebec River during the Revolution, War of 1812, Civil War, and Spanish War. In 1607 - English made attempt to colonize nearby and further west - see markings on a boulder perhaps indicating a Viking landing.

Fig. 1.

Bladder Wrack, Rockweed

Where is this algae found?
What color is it?
How does it float?
Are there other plants growing on it?
How do you think it grows?

Knotted Wrack

How does this plant get its name?
Can you find its air bladders?
Describe the shape of this plant.

Fig. 2.

Fig. 3.

Irish Moss

What color is this?
Are there other plants and animals on this plant?
Why do people collect this seaweed?
Look down in the low tide area for this plant.

Sea Lettuce

Look in the upper tide pools for this.
What does it look like?
How does it get its material for growth?

Fig. 4.

Fig. 5.

Look at a piece of rockweed with a hand lens.

What sort of animals and plants do you see?

How is this like a little community?

a. Porphyra
b. Gigartina
c. Coralline Algae
d. Dulse
e. Encrusting Algae

These are red algae. What use are they to you?
Look way down at the water's edge for these.

Fig. 6.

Fig. 7.

Kelps grow down on the water's edge.

Why don't the seaweeds need true roots, stems, or leaves?

Sticklebacks are usually found in marsh areas and on mud flats in eel grass.

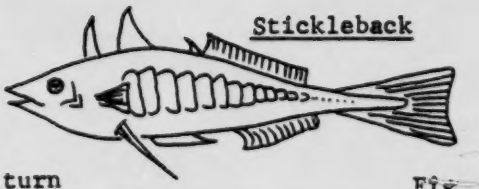


Fig. 8.

The Rock Eel may be found when you turn over stones in a tide pool. How are these two fish alike?

How are they different?
How do these fish protect themselves? Rock Eel

Fig. 9.

Dog Whelk

How is this animal different from the periwinkle?
Look up around the barnacle zone for this animal.
What does it feed on?
How many shells does this animal have?
You will find its eggs under the seaweed in late spring.

Where are these animals found?
What do they feed on?
What does it use its trap door for?
When the door is open what does it look like?
Can you find its head?
How does it move about?
Can you guess how it breathes?

Fig. 10.

Periwinkle

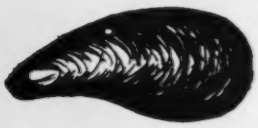


Fig. 11.

Where are these mussels found?
Are there any other animals like this?
How is this animal attached to the rocks?

Blue Mussel

This animal is not a member of the clam and whelk group.
What does it have that is like these animals? that is different?
Watch these animals in a tide pool. How do they feed?
Can they move?

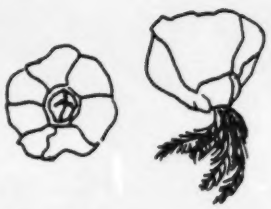


Fig. 12.

Barnacle

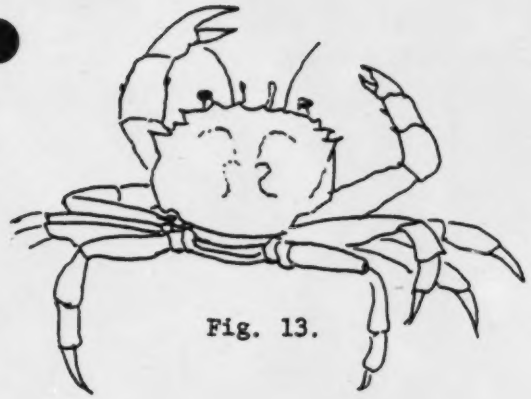


Fig. 13.

Green Crab

Turn over the rockweed and you will find this animal.
How many legs does it have?
What does it eat?
Describe its home.
How does this animal breathe?
How does it see?

American Lobster

You may not find a lobster in the rocky shore area, but you may find parts of him. He usually lives in deeper water.

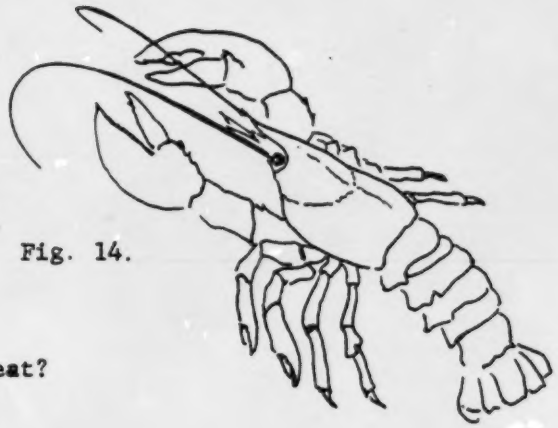


Fig. 14.

How does a lobster move?
What kinds of things does he eat?
Describe where it might live.

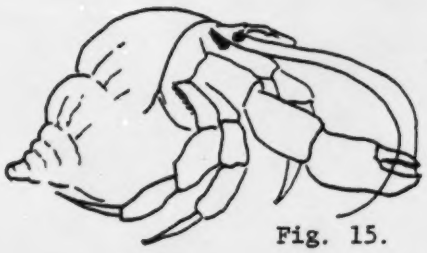


Fig. 15.

Hermit Crab

You will find hermit crabs in intertidal pools.

Where does this animal get its home?
What is he like without his home?
Watch this animal carefully. How does it react when another hermit crab comes near it?

Amphipod

This animal is not an insect. If this is so, who are its relatives?

You will find these animals when you turn over rocks in the intertidal pools.

Fig. 16.

Where else does it live?

Fig. 17.

You will have to look in the crevices for for this animal.

What happens when you touch these animals?
How does it feed?
How does it protect itself?

Sea Anemone

Is it a plant or an animal?
What color is it?
Are there other plants or animals like it?

Fig. 18.

Crumb of Bread Sponge

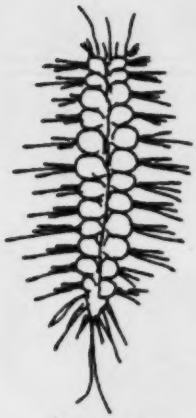


Fig. 19.

Scaleworm

Where does this animal get its name?
Where does this animal live?
How does it breathe?
Look at its sides. How can it move?
Where is its head?

Springtail

Why is this animal an insect?
Look in the upper tide pools for these animals. Have you ever seen these animals before?

Fig. 20.

Fig. 21.

Razor Clam

How does this animal get its name?
What other animals are similar to it?
Where does it usually live?
How does it move?

Slipper Shell

How many shells does this animal have?
Where is it found?
What does it eat?

Fig. 22.

Fig. 23.

Tube Worm

This animal is very small. Where do you find it?
What does it do when it is underwater and undisturbed?
What does it do when it opens its trapdoor?
How does it feed?

Moon Jelly

You may find this washed up on the shore.
What kind of animal is it?
Where does it usually live?
How does it eat?

Fig. 24.

Fig. 25.

Limpet

How many shells does this animal have?
Find its strong muscular foot. How does it use its foot?
Where is the head?
Where does it live?
How is it able to live the way it does?

Chiton

How is this animal like the limpet?
How is it different from the limpet?
Does it have a foot?
How does it breathe?
Does this animal have any armor?
What does it eat?
Where do you find it?

Fig. 26.

Fig. 27.

Moon Snail

Is there an animal inside?
What does it do when you touch it?
How does the moon snail move?
Does it have a trapdoor?

Deep Sea Scallop

How many shells does this animal have?
Is there an animal inside?
How does this animal grow?
Are there any animals on the outside of the shell?
Name some other animals like this.

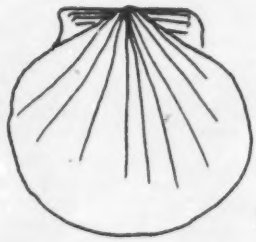


Fig. 28.

Fig. 29.

Sea Urchin

How is the sea urchin protected from its predators?
Usually one only finds the skeleton (test) of this animal.
What does the shape of this animal resemble?
How does it move?
Where is its mouth?
Turn it over on its back. What does it do?

Common Starfish

How does a starfish breathe?
How can it eat?
What is the eyespot really for?
Can a starfish see to find its food?

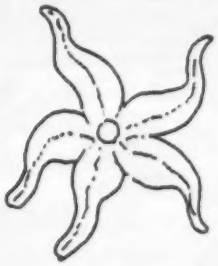


Fig. 30.

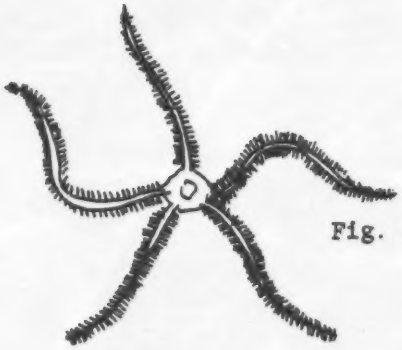


Fig. 31.

Brittle Starfish

Why is this a good name for this animal?
Who are its relatives?
What do they have in common?
How does the star move?
Turn over the stone in a tide pool, you may find more.
Remember to put the stones back the way you found them.

Sand Dollar

You may only find the skeleton of this animal.
How is this animal like a sea urchin?
Where is the mouth?

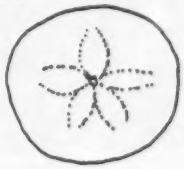


Fig. 32.

Fig. 33.

Sea Squirt, Sea Pork

How many individuals are in the colony you have found?
How do they feed?
Do you think that you belong to the same group of animals as these organisms?

Sandworm

These worms live in a burrow during the day, but emerge to feed during the night.
Do these have any commercial value?
How do people harvest them?

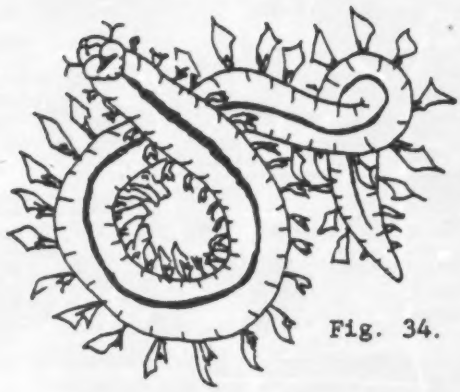


Fig. 34.

APPENDIX I

Resource People:

The following people may be contacted for other possible field sites and areas to visit:

1. Kennebunk, Ogunquit through Old Orchard Area (York County), Alfred Co. Ext. Service. Office phone 324-2814.

2. Pine Point through Brunswick Area: Cumberland Co., Co-op Extension Service.

3. Harpswell, Bailey Island, Orrs Island, Phippsbury (Popham Beach), Reid State Park, Boothbay Areas. Alton Gustafson (past Marine Science NSF Institute) Bowdoin College. He is retired but may be reached through the college.

4. Boothbay Region (Westport, Southport, Ocean Point), Christmas Cove, Damariscotta River Area and Damariscove Island, The Marine biological research center (Darling Center), Pemaquid Point, Round Pond, Rachael Carson Preserve - Salt Pond, Round Pond, Friendship. For information call the Darling Center, Walpole, Maine, 563-3146.

5. Port Clyde, Tenants Harbor, Spruce and Owls Head, Rockland through Bucksport area. Also knowledge of many other sites and programs. Paul Ring, Co. Extension Service, Marine Advisory Service, Main St., Rockland, Telephone: 594-2104; Home: 677-2260 (Biology experience, land use).

6. Hancock and Washington County Areas. For commercial fishing, site areas all along the coast to West Quoddy Head, also statewide representative for visitations. David Dow, Marine Advisory Service and Cooperative Extension Service, Ellsworth Ext. Office, Christian Ridge Road, Telephone: 667-8212.

7. Bar Harbor, Acadia National Park, Lamoine Beach, Winter Harbor, Prospect Harbor Area. Marine biology background, coastal field trip sites, activities. Wes Hedlund, University of Maine, Shibles Hall through Dr. John Butzow, College of Education, Telephone 581-2754 or Bangor High School, Biology Dept. 942-6711.

8. Washington County (Cobscook Bay Region, Quoddy Head, University of Maine Machias Area, Dr. John Comitto, University of Machias Biology Department., Telephone: 255-3313.

9. For Lubec area, Deer Island, Campabello Island (New Brunswick, Canada) Good resources, history, field sites, (biology, fishing, canneries, etc.) Dick Gleuck - in Bangor, Telephone: 942-0260

10. State Department of Marine Resources, State House, Augusta. Lorraine Stubbs, Marine Science Educator. Presently working on commercial fishery units. These include the biology of marine organisms such as lobster, commercial fish, etc. These are excellent teacher resource materials. Telephone: 289-2291.

A FEW OTHER SOURCES

1. Audubon Society of New Hampshire
   Education Director
   3 Silk Farm Road
   Concord, New Hampshire 03301
   Telephone: 603-225-9909

2. Department of Conservation, Parks and Recreation
   Information and Education Division
   State Park Service
   Augusta, Maine 04330
   Telephone: 207-289-2212

3. Department of Interior, Fish & Wildlife Division
   Refuge Headquarters, Park River National Wildlife Refuge
   Newburyport, Massachusetts 01905
   Telephone: 617-465-5753

4. Department of Resources and Economic Development
   New Hampshire Division of Parks
   State House Annex
   Concord, New Hampshire 03301

5. Maine Audubon Society, Education Director
   Augusta, Maine 04330
   Telephone: 207-781-2330
   or
   Tilsland Farm
   118 Old Route 1
   Falmouth, Maine 04105
   Telephone: 781-2330

6. New Hampshire Fish and Game Department
   Education Division
   Bridge Street
   Concord, New Hampshire 03301

7. University of New Hampshire Marine Advisory Program
   Julia Steed, Marine Education Specialist
   Kingsbury Hall
   Durham, New Hampshire 03824
   Telephone: 603-862-1889

8. Maine Marine Advisory Program
   Sea Grant Office - Coburn Hall
   University of Maine at Orono
   Orono, Maine 04473
   Telephone 581-2666

9. Inland Fisheries and Wildlife Department
   Illinois Avenue
   Bangor, Maine 04401
   Telephone: 942-2565

   or

   Fish Hatchery
   Enfield, Maine
   Telephone: 732-3676

APPENDIX II

SITES

The following are only suggested areas for your field trips; there are many more along the coast.

1. Campabello Island - This is worthwhile from an historical point of view as well as its natural history and fishing (sardine factories to fish weirs and fishing fleets around the Head Harbor area). The Roosevelt Campabello International Park is located here, also. Sandy and rocky beaches are very accessable along the way to Head Harbor Light House. Herring Cove and Wilson's Beach are typical. The strong currents of this area and the proposed route for oil tankers may be observed around the lighthouse area. (Tide Range 28 feet or more)

   Wilson's Beach - This hosts a typical Canadian island fishing cannery. Tours are available. Beam, stern trawlers, long liners and lobster boats may be observed here.

   Herring Cove Park (Public) - This is a sand beach unique to Campabello. (Very picturesque and protected). Picnicing facilities are available. There is flotsam and jetsam to be observed such as skate egg cases, mollusk shells, sea urchins, etc.

   Behind Friar's Bay Gift Shop (1 mile beyond the Roosevelt Park) - A sandy, gravely beach yields such things as Irish moss, kelps, sea lettuce, isopods, periwinkles (commonly harvested and taken to Boston). Unique and simple dories, repairing of fishing nets and a wreck of a 4 masted coastal schooner may be observed. It had caught fire and in an effort to save the rest of the fleet, the hawser was cut and she was allowed to drift to her last resting stop.

2. Deer Island, New Brunswick - Evidently the Canadian government runs a ferry from here free of charge. There is also a scow ferry here that a group may take to observe jellyfish in the late spring and whales during late summer and early fall. Larger ferries may be taken to Grand Manaan. An excellent exhibit is on display at Manaan's museum.

3. Quoddy Head State Park (four miles off Rte 189 at Lubec) - This is the Easternmost point of land and lighthouse in the U.S. Rock ledges from 50 to 190 feet rise from the ocean. Spruce and fir represent a climax community. Good example of plant succession is here. To the right of the lighthouse a path will go for several miles where one may see wind throws and succession. Along the shore there is a great deal of algae and animal life. There are isolated tidal pools and cobble beach. On a good low tide laminariams and other forms of kelp may be seen. This is a favorite sight for watching seals and whales. Grand Manaan Island may be seen off shore. Campabello Island is just a short trip from here.

4. Town of Cutler - municipal wharf. In this quiet harbor one may observe large tidal ranges and growth on the pier pilings of the lobster piers. There are beaches along the sides that offer some plant and animal forms. The kelps grow very large here and there is an abundance of amphipods.

5. Cobscook Bay State Park Area - Cobscook means "boiling tide" which describes the constantly changing water level. The Cobscook Bay area offers a host of areas for exploration. The state authorities may be contacted for suggested sites. The types of shore vary from gravel to cobblestone to mud. Intertidal life is abundant.

   Federal Harbor - mud flat ringed with a salt marsh. Some rocky areas carpeted with rockweed, green algae on mud flat, clams, worms abundant. See Dr. John Committo at the University of Maine for directions and information.

   Holmes Bay (off Rte 191 in Whiting, Maine) - There is a large sand flat behind the A.M. Look Canning Corporation. There are rocky areas with erroding sand and gravel banks. There is a good variety of algae here for the ocean is more open here.

6. Reversing Falls Town Park (Pembroke, Maine) - This is off the Lake Neck Road. Swift tidal currents may be observed. At any location along the road one may see sea urchins, starfish and lots of seaweed.

7. Jaspers Beach (In Howards Cove between Bucks Harbor and the town of Starboard) - A pathway to the right of the two Radar domes leads to a cove at the bottom of the hill. Semiprecious stones may be seen on the cobble beach. There are ledges at each end of the mile long beach with a brackish water pool behind with extensive marsh. Purse seining may be seen from this site.

8. Roaque Bluffs State Park (Roque Bluffs, Washington County) is a long sandy beach with rock ledges on either side. One extends out well into the ocean. Brachiopod fossils are found in this area. The site is characterized by steep granite bluffs about 40 feet high. The zonation is good here, not an abundance of tide pools but large cracks which retain water and allow a great amount of diversity. The barnacle zone is well developed, patches of mussels with their associated life, rockweed, sea lettuce, red algae, bread crumb sponges, the dog whelk, amphipods, encrusting algae, the marine insect Anurida, two different periwinkles and the limpets are found here. A salt pound is located behind the beach; one can study the sand dunes, too. There are picnic tables and restrooms.

9. Jonesport - Town Park - This area yields mixed gravel, sand and muddy bottoms. There are out-croppings of rockweed and tidal pools offering a diversity of life. This locale is good from the commercial aspect also. The life centered around lobstering and pounds, purse seining, gill net fishing, worming and clamming may be observed.

10. Corea and Prospect Harbor (off Rte 195) There are a number of areas to be studied in this region. Prospect Beach is a public beach located

one cove N.E. above the town of Prospect Harbor where Stinson's cannery is also located. This beach offers views of strand lines and bordering the sides are rocky ledges which offer good zonation and isolated tidal pools. N.W. of this beach the ledges extend out into shallow water to small rocky islands. There are numerous organisms that may be viewed here on a good low tide. Representatives of green, red and brown algae, large kelps, starfish, sea cucumbers, hermit crabs, whelks, periwinkles, sea urchins and even sand dollars are found here.

11. Winter Harbor - Follow Rte 186 into the town. Take a right at the intersection of Rte 186 and the main street of the town. Follow the main road approximately 1/2 mile beyond the town and take a right onto the Grindstone Neck Road. This leads to Grindstone Neck Beach which shows some interesting geology and zonation. Pink granites and basaltic dikes may be viewed here. Blue-green algae grows profusely on the rocks which are very smooth from the pestal and motor action (grinding) of the round cobble stones on the ledges. This makes them very slippery. There is good variation of algae and animal forms including sea anenomes in isolated pools. One may also leave the Grindstone Neck Road and turn left onto the Main Road. Follow the main road another half mile and take a left on to a dirt road. This leads down to a number of rocky beaches in Deep Cove which offer good geology and zonation features.

12. Ellsworth to Schoodic Point (whole day trip) - For those schools in the Penobscot, Hancock and even Piscataquis Counties, an excellent trip may be made with many geological, types of shore, and intertidal life observations. Approximately 150 yards above the Union River Bridge on Rte 1A the Ellsworth Schist may be seen. This is an out cropping of ledge on the right hand side of the road. Glacial striations (scraping marks) may be seen in the rock where the last glacier passed 10 - 15,000 years ago. Follow Rte 1A to the intersection where Dunkin Donuts is located. Take a right here and follow this road out about 6 miles. On the right hand side you may see a couple of gravel pits. A stop here will reveal geological features such as ancient river deltas and old river beds which one may see from the cut-away landscape. This road leads back onto 1A. Follow this and about 6 miles beyond, there are some beautiful views of the Mount Desert Island mountains which were also formed by the glacier. A few miles beyond this Long Cove may be seen. This is an excellent picnic area and a mud flat is located here. At low tide carpets of green algae are evident as well as sticklebacks, mummichogs, sand shrimps, soft shell clams, eel grass, periwinkles, mud snails, etc. A lagoon is located at the head of this cove and offers typical rocky shore zonation as well as reversing tides. One may walk the shoreline to get to this spot. After this visit follow Rte 1A to Sullivan Bridge. Continue on Rte 1A to Rte 186 into the town of Winter Harbor. Follow the signs to Acadia National Park. The first stop as you come into the park is Frazer Point. Restrooms and picnic tables are here. A clamming area and rocky area with some zonation may be viewed. Driving along the one way road beyond this at least 5 or 6 stops may be made. Stack and boulder beaches of the pink granites, excellent zonation, surf, steep cliff walls and excellent views of Ironbound, Turtle and West Pond Islands all make this worthwhile. The grand finale is a visit to Schoodic Point which attracts thousands of people each summer. This has all of the above life and facilities. The one way road leading back to Winter Harbor offers more beaches to be seen.

13. Lamoine State Park (Rte 184 from Ellsworth) - Picnic, campsites at Frenchman's Bay, boat ramp, floating dock are available. There are sandy beaches as well as rocky intertidal areas.

14. Lamoine Public Beach (above Lamoine State Park). This has a sandy gravel beach with a rocky ledge bordering the right side. Intertidal zonation or organisms, strand lines, flotsam and jetsam are viewed. Picnic tables, grills and facilities are available to the public.

15. Trenton to Bar Harbor, Acadia National Park. Another excellent day trip may be made in this area. Under the Trenton bridge collections of dulse can be made and numerous periwinkles found; other forms of red algae can be viewed from spring through the fall. An information center is located beyond this bridge. Follow Rte 3 to Acadia Park entrance. Stop at the Ranger's headquarters. Exhibits, park information, and maps may be of some value. Leave the headquarters and take the Ocean View Drive road. Some of the most spectacular ocean and island views in Maine are along here. You may want to take a side excursion to Champlain Mountain first.

    The second stop along ocean drive is Sand Beach. The beach is composed of minute animal shells not silica. Sea urchin spines and mother-of-pearl may be examined with a hand lens. Rocky ledges are located on the left and right sides of the long beach. Some zonation is evident.

    Follow the road beyond to Thunder Hole. This is well named and is self explanatory. Beyond this are Otter Cliffs. Vertical zonation is good here. Three or four miles beyond this on the one way drive Otter Cove is located. Strand lines and beach shells are bountiful there. About 1½ miles further is Little Hunters Beach. A walkway leads from a stone bridge down to a cobblestone beach. There are a few tidal pools and good intertidal forms located here.

    A side trip could be made to Northeast Harbor. This is a popular harbor for cruising boats as well as for lobstering and fishing boats. If time allows, a side excursion could be taken with the Sea Princess or Island Queen to Cranberry Island. A museum is located on Islesford.

16. The Oceanarium (Town of Southwest Harbor). This is another trip or side excursion. Allow at least an hour or two for the visit. Follow the signs from the main part of the town. Dave Mills and his wife run this program from May 15 to October 21. Specimens may be viewed and tanks and touch boxes. Exhibits on fishing gear such as scalloping, lobstering and commercial fishing are displayed. Slide shows and stories from two local lobstermen are additions. A nominal charge of $.80/student is made. These folks also run school visitation programs after January 1.

17. Blue Hill Falls. Follow Rte 175 from the town of Blue Hill until you come to the steel bridge. This has the reversing falls from the Salt Pond. At low tide hermit crabs, blue mussels, barnacles, sea urchins, periwinkles and a host of intertidal life is available here. In July

such things as Beach Peas, salt wort and Irish moss could be collected for pressings and later exhibits.

18. Castine - If you have a couple of scuba diving friends, collections can be made under the town wharfs next to the Maine Maritime Academy's State of Maine merchant ship. This is an excellent collecting ground for old scallop shells, good for scrimshaw work, starfish, sea anemones, sea urchins, nudibranchs, blue mussels, whelks, encrusting algae, etc. Then you may visit the State of Maine and the Allee Ryan ship Museum on campus.

    Follow Rte 166 back out of Castine to Rte 175. Shortly after being on Rte 175 you will see a mud flat or cove area on your right and a sign marked the British Canal on your left. Take the first road to the left and a sandy gravel beach will come into view. This beach has good strand lines, patches of blue mussels, soft shell clams, rockweed and barnacles. Digging is necessary to obtain the clams. Sand worms and blood worms are also found here. On the opposite side of the road a small lagoon has sticklebacks and mummichogs. This whole area is rich in history of the American Revolution.

19. Moose Point State Park (between Searsport and Belfast on U.S. 1). There is a scenic view of Penobscot Bay. It has a grave; and rocky beach. Some intertidal forms may be observed. Picnic tables and grilles are available.

20. Camden Harbor - In extreme low tide conditions rockweeds, periwinkles, starfish and other forms may be seen. There is a lot of fresh water mixing from a stream out of Megunticook Lake so the diversity of life is not as high here as in open ocean areas. Some colonization of life may be viewed on wharf pilings. This is a good area to view boat traffic and get a glimpse of the schooners.

21. Rockland Breakwater. Follow Rte U.S. 1 into Rockland and get directions to Beacon Point. The breakwater is located at the tip of the point. Intertidal forms may be viewed all along the edges at low tide.

22. Deep Cove (St. George). There are a series of 4 beaches along this cove between Hooper and Howard Points. A wide range of intertidal life is available here in a mixture of different types of shore.

23. Port Clyde Lighthouse (St. George, Knox County) - Follow Rte 131 from South Thomaston to town of Port Clyde. Get directions there to lighthouse. This beach area around the lighthouse is protected from the south but open from the southeast. There are numerous crevices and small tidepools at all tidal levels. The zonation is indistinct but life abounds; clumps of Irish moss, kelp, rockweed, thread-like green algae, dog whelks, periwinkles, blue mussels, round worms, starfish, hermit crabs, brittle stars, amphipods, sea urchins. There are also broken shells and fragments in the crevices. Parking is available near the lighthouse keeper's house.

24. Pemaquid Point (Bristol, Lincoln County). Take U.S. 1 to Damariscotta. Follow Rte 129 out of the town until it intersects with Rte 130. Follow Rte 130 to the end. This is an ideal area to study a rocky shore. It is all ledge of granite rock. The tidepools are large and numerous. A number of colleges use this as a study site in the summer. The upland area has a few spruce trees. A parking area is available. There is rockweed, thick growths of Irish moss, mats of blue mussels, sea lettuce in protected areas, coralline algae encrusting rock surfaces. There are a number of species commonly found in the tidal pools. The bread crumb sponge, scale worms, limpets, whelks (multicolored, the northern starfish, sand worms, nudibranches and brittle stars abound here. The barnacle zone is well developed. The most common animal is the periwinkle.

25. Ocean Point (Boothbay Harbor, Lincoln County). Take Rte 96 from East Boothbay and follow the signs to Ocean Point. This area is bounded by three large summer cottages. It has mostly granite ledges with some metamorphic rock and is partially protected to the southwest by Fishermen's and Green Islands. The intertidal zonation is well defined. The degree of beach slope is up to 30°. The area is covered with Irish moss, Coralline algae, sea lettuce, filamentous green and brown algae, kelps, rockweed. Animals include roundworms, limpets, 3 different types of periwinkles, whelks, blue and ribbed mussels, boring bivalves, rock crabs, green crabs, northern star and sea urchin, nudibranchs blood star, isopods and the rock blenny (fish) may be found in the lower tide pools. The barnacle and periwinkle zones are well defined, too.

26. Cape Newagen (Southport, Lincoln County). Take Rte 238 from Southport. Follow this to the point past the town of Newagen. The point may be seen from the road. The area is exposed to the southwest and the upland area consists of a number of cottages set in the spruce trees. It is protected to the southeast by Cape and Hunting Islands. Slope is variable from 5° - 70°. Zonation is distinct and many of the species of plants and animals listed for Ocean Point may be observed. In addition the flowering anemone may be seen in tidal pools.

27. Reid State Park (Rte 127 from Woolwich, 14 miles to park sign). This is an excellent area with all the necessary facilities. The area consists of 1½ miles of sand beaches, dunes, marshes and ledges. The rocky intertidal area is made up of metamorphic rock -- most by schist. The area is constantly exposed to the open ocean. Some of the algae reflects the stress from the pounding waves. All of the organisms listed at Ocean Point may be found in the intertidal zone.

28. Popham Beach State Park (Rte 209 from Bath to Phippsburg, follow park signs). An extensive beach of light, fine sand, sand bar with tidal pools and rocky out crops may be explored here. Old Fort Popham, site of first attempt by the English to colonize New England, is located nearby.

29. Bailey Island (Harpswell, Cumberland County). There are many areas along Rte 24 that may be examined. This area could prove very productive. It has been quantitatively sampled by the Bigelow

Laboratory in an intertidal inventory study for the Maine State Planning Office. Sixty-four different plants and animals have been identified here. All of the organisms listed previously and in addition sea squirts, flat worms and hydroids may be located here. A lot of the rocky areas have 60° - 80° slopes which give a tremendous range of isolated tidal pools. Kelp is found just subtidally. The lower tidal pools are continually flushed with seawater and will provide the greatest diversity of life.

30. Port of Portland. There are no primarily large ledge areas along the Portland waterfront but the pier pilings offer areas of study. The gravely sandy areas of Eastern Promenade, specifically Fish Point, offer some intertidal organisms. The harbor could be the focus of an unlimited number of studies, though, such as oil transport, cargo movements, tug boat operations, historic sites, ship repair, Coast Guard operations, pollution abatement, etc. This harbor is a good jumping off point for the 365 "Calendar Islands" of Casco Bay, too. Casco Bay Lines offer cruises.

31. South Portland - SMVTI & TRIGOM. The Southern Maine Vocational Technical Institute and the Gulf of Maine Marine Aquarium project at TRIGOM are very educational programs to visit. Debbie Hall, 21 Vocational Drive, South Portland, Telephone: 799-6234, is the advisor to call.

32. Two Lights State Park (off Rte 77, Cape Elizabeth). The highly eroded metamorphic rocks resemble petrified trees lain side by side giving a slabby step-like appearance. There are many sizable tide pools at all tide levels. The zonation is obvious but not sharp because of the flatness of the slope. The upland area consists of a parking lot and grass. The Irish moss zone consists of a thick mussel-moss mat which is home for numerous round, segmented and ribbon worms. Kelp is dominant in the lower zone; sea lettuce encrusting and filamentous red algae, bladder wrack and knotted wrack are a few of the algae. Limpets, whelks, arctic clams, barnacles, northern stars, brittle stars, isopods, and bread crumb sponges may be found in the intertidal pools. Green and rock crabs are sometimes evident, too. There is a great amount of diversity at this location. This park is also close to Crescent Beach State Park where an excellent sand beach is located. Strand lines, discarded hen clam shells, flotsam and jetsam are abundant here.

33. Higgins Beach (off Rte 77 in Scarborough). The sandy part of this beach has been washed out partially from winter storms. To the right of this are rocky intertidal areas. It can be reached along a foot path to the right of the beach. Flora and fauna are similar to the Two Lights site.

34. Prouts' Neck Area - Jordans Beach (off Rte 77, follow signs). This beach has access to the whole east side of Prouts' Neck. About 1½ miles of sandy beach stretch out at this site. The area is bounded by rocky ledges on each end. There is a long stretch of beach on the west side as well. Ferry Beach will bring one into this area.

Parking facilities are available. There is a small fee in the summer. This area does not abound in rocky intertidal life but numerous dried specimens of razor clams, sand dollars, horse shoe crabs, moon snails, soft shell clams, hen clams may be found in the flotsam. One may also view Pine Point Beach from this site. The whole area between Pine Point and Old Orchard would result in similar findings on the sandy beaches.

35. Scarborough Marsh Nature Center. This is sponsored by the Audubon Society. It is open from April through October. There are two park naturalists available for tours of 1½ - 2 hours duration. This is an excellent educational experience which also introduces students to three different environments: dunes, marshlands and tidal pools. This is a "hands on" sensory approach. Introductory materials, reading lists, and follow-up activities are supplied through the Gilsman Farm of the Society located in Falmouth.

36. Biddeford Pool, Fortune Rocks, Goose Rocks, and Hoyt Neck (Biddeford, York County) - All of these areas are reached from the town of Biddeford off Rte 9/208. Hoyt Neck is typical. It is made up of rounded granitic rock. The whole area has the appearance of fingers with huge boulders, cracks, crevices, and tide pools between the fingers. Although many of these areas do not offer "textbook" zonations, many of the intertidal flora and fauna may be seen. In particular all four types of periwinkles, hermit crabs, blood and brittle starfish are worth noting.

37. Kennebunk Beach (follow Rte 9 south out of Kennebunkport and take a left at the four corners, watch for signs). This is mostly made up of shingle (rounded beach stones). There are some isolated tidal pools. It may yield some interesting driftwood or other flotsam.

38. The following sites are available in the very southern most section in Maine and New Hampshire. Julie Steed of the New Hampshire Marine Advisory Service is a good contact for these:

Rachel Carson National Refuge
Brave Boat Harbor
York, Maine

Nubble Light
York, Maine

Fort Foster & Fort McClary
Kittery, Maine

Adams Point
Durham, New Hampshire

Odiorne Point State Park
Visitor Interpretive Center
Rye, New Hampshire

Bellomy River Sanctuary
Audubon Society of New Hampshire
Dover, New Hampshire.

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